

HAYEK BCV

Biphasic Cuirass Ventilation

A woman with long blonde hair is sitting on a light-colored couch. She is wearing a white long-sleeved shirt and a large, clear, dome-shaped cuirass ventilator over her chest and back. The ventilator has a black strap around the top and a clear corrugated tube connected to the front. The word "HAYEK" is embossed on the front of the device. She is holding an open book and looking down at it. The background is a plain white wall with a white door frame visible on the right.

APPLICATION OF THE HAYEK RTX

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Patient Criteria

Partial List of Indications

Acute Respiratory Failure	Neuromuscular Disease	Bronchiectasis/Cystic Fibrosis
Problems with Weaning from PPV	Asthma/Bronchiolitis/Bronchitis	Cor Pulmonale
Atelectasis/Retained Secretions	Hypoxemia, V/Q Mismatch	Fatigues Easily Post Extubation
Increased WOB/Dyspnea	Low CO State or High Potential with PPV	Post Fontan/Fallot
Cardiogenic Pulmonary Edema	Bridge to Lung Transplant Needed	Lung Protection and/or Recruitment in high MAP/Pplat PPV Situations
AIDS Related Lung Disease	Head and Spinal Injuries	Ventilation During ENT & Bronchoscopic procedures
Chronic Obstructive Pulmonary Disease (COPD)	Post-op/Recovery Ventilation	Pulmonary Artery Hypertension

Additional Consideration & Contraindications List



Burned skin or draining wounds under shell or seal area	Indwelling lines, tubes, or drain where point of entry into the skin are under seal (within shell is fine)	Weight > 180 KG
Patient's thoracic structure precludes establishment of good seal	Lack of viable airway either natural or artificial	Cardiopulmonary arrest

- ▲ Utilize standard assessment measures for specific illness to determine tolerance.
- ▲ CNEP may be used adjunctively with PPV. Respiratory drive consideration branch may be bypassed if on set RR and VT via PPV.
- ▲ Patient with soft tissue airway obstruction can receive benefit of BCV with use of mask CPAP or airway adjunct.
- ▲ Provide supplemental O₂ via nasal, facial delivery devices or artificial airway as indicated to meet immediate oxygen requirements.

Accessory Check-List

Gather necessary patient accessories:

- Blue Cuirass Pressure Sensor Tubing (Single Patient Use)
- Clear Airway Pressure Sensor Tubing (Single Patient Use)
- Wide Bore Tubing (Adult/Ped. Single Patient Use)
- Appropriate Cuirass Shell Size (Non-Disposable)
- Corresponding Seal Size (Single Patient Use)
- Cuirass Straps (Single Patient Use)
- Pediatric Adapter (If Needed)



Cuirass Fitting

To identify the correct cuirass size for the patient, refer to sizing grids for best estimate of starting size.

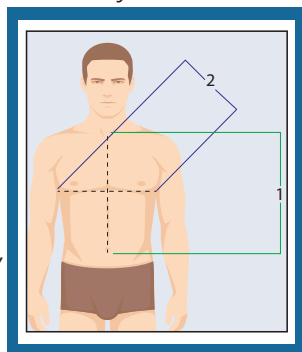
Carefully consider the patient's size and shape when fitting, select the largest cuirass size that will ensure a good seal for the greatest therapeutic effect. More than one size will fit most patients.

Adjustment to larger or smaller may make a difference. Estimate size by weight or measurement.

Measurement 1 from sternal notch to just below umbilicus.

Measurement 2 across chest from axilla to axilla. Both measurements are not to follow contour of body, but rather an imaginary line straight across the body to apply accurately.

- Using the size grid (see Cuirass Size Measurements), the closest cuirass size to the two measurements will usually work best.
- It is preferable that the cuirass length measurement slightly exceed the vertical measurement of the patient.
- Horizontal cuirass measurement can vary slightly from patient width without affecting performance, if too narrow may add restriction.



Cuirass Shell Measurements

Weight gives quick estimate.

The following table indicates sizing by weight.

	CUIRASS	APPROXIMATE WEIGHT (Kg)
Small Infant	0*	1.8 - 3.5
	1*	1.8 - 3.5
	2*	3.5 - 5
Infant / Pediatric	3*	5 - 7
	4	7 - 15
	5	15 - 20
	6	20 - 35
Adult	7	35 - 50
	8	50 - 75
	8B	50 - 85
	9	75 - 90
	10	90 +

*Requires pediatric adapter

Measurement gives most accurate estimate of correct size choice.

The following table indicates sizing by shell.

CUIRASS SIZES	HEIGHT		WIDTH	
	Inches	cm	Inches	cm
0*	7.1	18	4.9	12.5
1*	7.9	20.1	5.3	13.5
2*	8.9	22.5	6.1	15.5
3*	9.7	24.5	7.1	20
4	10.6	27	9.2	23.3
5	11.1	28.3	9.2	23.3
6	12.7	32.2	10.7	27.3
7	14.4	36.5	12.0	30.5
8	14.6	37	12.6	32
8B	16	40.6	14.5	36.8
9	17.4	44.3	15.0	38
10	19.4	49.3	17.3	44

*Requires pediatric adapter

How to Apply the Seal

Ensure that you have the correct size seal for the cuirass shell. Avoid gripping the seal between fingers, use hand to stretch the seal gently—this will prevent ripping.

Note: Ensure extra seal is placed at the bedside as backup.



Step 1: When fitting the seal to the cuirass shell, place the seal's joint seam at the center top of the cuirass. Cuirass should be upright, facing away from you. The side of the seal with double padding should be proximal to you. Locate the inner flap on the distal side of the seal, this encircles the outside of the cuirass. Starting from the center top ridge, begin to attach the seal's top groove.



Step 2: When the seal fits the top ridge, turn the cuirass upside down. Position the seal between the cuirass and a solid surface to keep in place.



Step 3: Starting from below, gently stretch and ease the seal's inner flap into position on the right and left side of the cuirass.



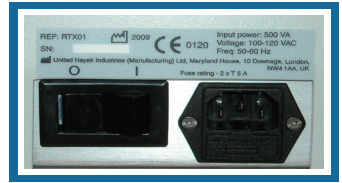
Step 4: Gently fit the remainder of the seal to the corner and the bottom ridge edge of the cuirass. Once the seal attaches around the sides of the plastic, adjust it so that the lip of the seal fully covers the ridge all the way around, to ensure the best possible seal.

Power Up, System Assembly and Setting Entry

In lower right corner of the right side of the machine is a black toggle power switch. Press to power on.

Unit Self Test: Unit will complete an initial self test before starting in same mode with all settings preserved from its last use.

Clear Apnea Delay Alarm Until Required: Apnea Delay Alarm will be restored to a setting of 20s with each new power up. It should be cleared until indicated. Set Apnea Delay Alarm to 0 to disable.



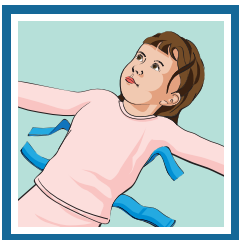
MENU → **ALARM MENU** → **APNEA** → **CHANGE 20 TO 0 ON NUM PAD** → **ACCEPT**

The Apnea Delay Alarm is relevant when using an Airway Sensor for sensing modes or to monitor for apneas.

Connect Wide Bore Tubing to the front of the ventilator and Blue Pressure Sensor tube to the cuirass sensor port. Connect the other side of the tubing to its corresponding place on the shell.

Apply Cuirass to Patient

Note position of leads, lines, tubes or drains and plan position of cuirass so the seal will not pass over any points of entry and pad under any that cross beneath the seal. Press Start to initiate CNEP, once CNEP level is reached, secure the straps making sure they are not twisted in the back. Straps can be applied straight across or crossed in the back, whichever is most effective for the patient. Pull the straps snug so that they will not allow the cuirass to move around on the patient's chest when ventilating.



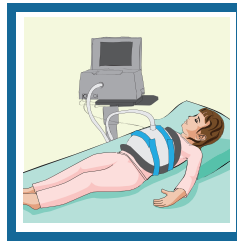
Step 1: Place the straps under the patient.



Step 2: Pull the sides of the cuirass open and place over patient's chest and abdomen. Flex and advance downward on chest until contact with sternum and abdomen achieved.



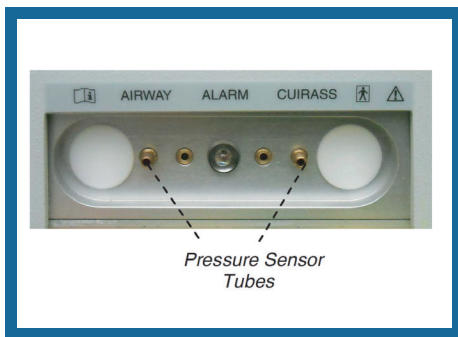
Step 3: Apply gentle fingertip pressure on front of shell or have patient hug shell, then start CNEP. Once pressurized, attach the straps to the cuirass and ensure that seal to patient is maximized yet comfortable. (See pg. 5)



Step 4: Seek potential leaks by running finger between foam and patient. Patient can be cared for lying in bed or in seated position or semi recumbent.

Ensure there is a cloth or clothing barrier between foam seal and skin. Ensure pressure ridges from lines crossing under seal are padded. If thermal losses noted, use additional insulation or warming techniques.

Seal to Chest on Continuous Negative Mode



Step 1 Attach the end of the Wide Bore Tubing into the port on the Cuirass and connect to the RTX.

Step 2 Attach the end of the Blue Pressure Sensor Tube to the small hole on the front of the Cuirass and connect the other end to the RTX.

Step 3 (Optional) For airway sensing and apnea alarm use, connect the Clear Pressure Tube to the airway pressure port and a sensing interface such as a nasal cannula or T-piece.

Set the Hayek RTX to Continuous Negative



Starting Therapy: Press Start/Stop to begin pressure delivery.

START/STOP

Top center of the screen should change from "Standby" to "On" highlighted in green. This will form a natural seal on the patient's chest, drawing in the cuirass. Apply the straps when set pressure reached.

If excessive leak present, low pressure and/or **Error 21** will occur with alarm. Use the Cancel key to clear the alarm condition. Ensure all tubing is in place and seal is properly adhered to the shell.

Carefully reapply cuirass with attention to good contact at sternum and abdomen.

Highly recommended to remove every 4 to 6 hours of use at least briefly to monitor the patient's skin and seal integrity.

Selecting a Mode

Press: **MENU** → **ACCEPT** → **MODE SELECTION**

Highlight the mode you require and press: **ACCEPT**

Set or Check the Parameter Settings

Once all parameter settings verified press: **ACCEPT** → **ACCEPT**

To begin, press: **START/STOP**

Note: Parameter Settings can be altered at any time during ventilation without interrupting therapy by pressing:

MENU → **PARAMETER SETTINGS** → **INPUT APPROPRIATE ADJUSTMENTS** → **ACCEPT**

Mode Specific Information and Indications

CONTINUOUS NEGATIVE MODE

Indications	Precautions & Considerations
<ol style="list-style-type: none"> 1. Recruitment of alveoli and small airways 2. Hypoxemia 3. Conditions of increased WOB 4. Small airways disease 5. Weaning from PPV 6. Can be used with PPV to counter side effects 	<ol style="list-style-type: none"> 1. Must have adequate respiratory drive 2. When used with PPV, may require decreased PEEP to avoid increased mean airway pressure 3. Works well for most early hypoxemic and hypercarbic respiratory failure

CONTROL MODE

Indications	Precautions & Considerations
<ol style="list-style-type: none"> 1. Weak or absent respiratory drive 2. CO₂ retention and/or dyspnea unresponsive to CNEP titration 3. Can be used with PPV in assisting mode with BCV rate to be greater 	<ol style="list-style-type: none"> 1. Mean cuirass pressure should always be kept more negative than -4. 2. At rates >60 Insp & Exp pressures should balance i.e. -15/+15 3. Δp should always exceed 10 cm 4. Maintain pressure ratio at or near 3:1 (ie. -21 / +7 or -15 / +5)

RESPIRATORY SYNCHRONIZED MODE

Indications	Precautions & Considerations	Setting Backup Settings
<ol style="list-style-type: none"> 1. Adequate respiratory drive with need for breath to breath assisted support of tidal volume 2. Dyssynchronous with Control Mode 	<ol style="list-style-type: none"> 1. If apnea occurs, it will default into backup rate at set pressures 2. Prolonged periods at 100% of trigger percentage may be auto cycling, consider less sensitivity 3. If trigger percentage is 85% or less, increase sensitivity 4. For sensitivity adjustment, lower value equals greater sensitivity 5. Maintain pressure ratio at or near 3:1 (ie. -21 / +7 or -15 / +5) 	<ol style="list-style-type: none"> 1. Set back up rate about half resp rate once supported

Continuous Negative Mode

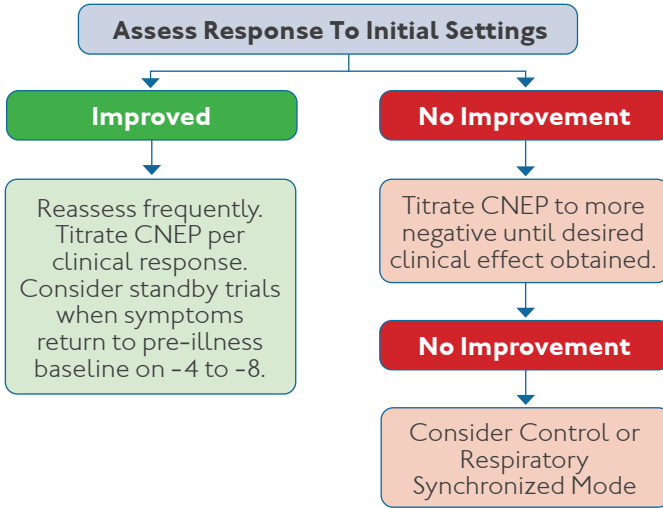
STARTING SETTINGS

Adult: -8 to -15cm

Pediatric: -6 to -10cm

Infant: -4 to -8cm

For extreme alveolar recruitment needs, work of breathing, or hypoxemia use: -20 or more negative



CURRENT MODE:	CONTINUOUS NEGATIVE	ON	NO ALARMS SET
Ins -20.3 Exp -19.7 Mean -20.0 I/E 1/1.5 Frq 22	CIRPASS		+25 -25
Ins -0.0 Exp -0.0 Mean -0.0 I/E 0/0.0 Frq 0	AIRWAY		+25 -25
N/A			+25 -25
N/A			+25 -25
SETTING:	CN= -20		

Control Mode

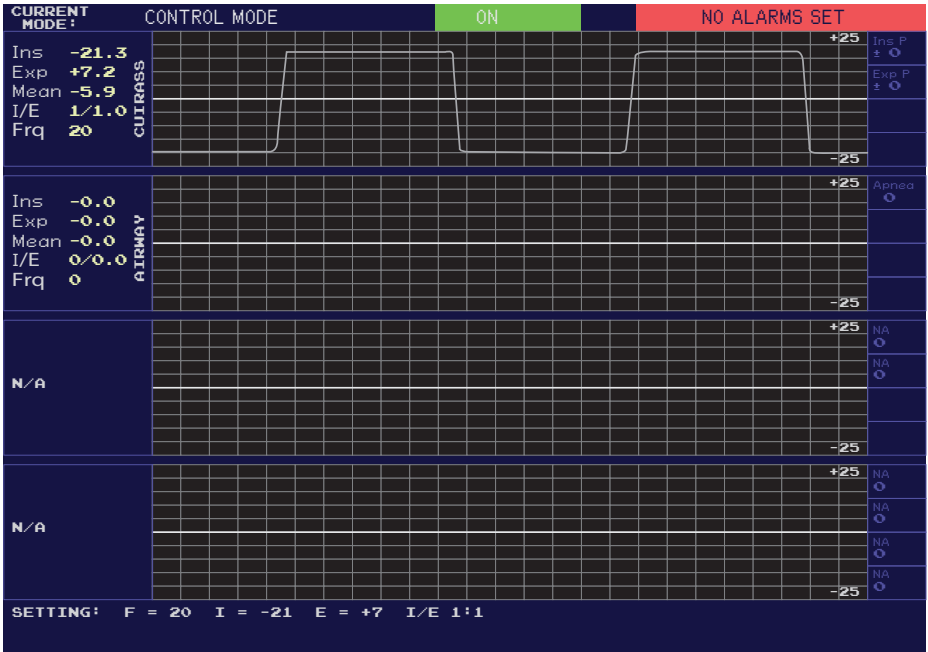
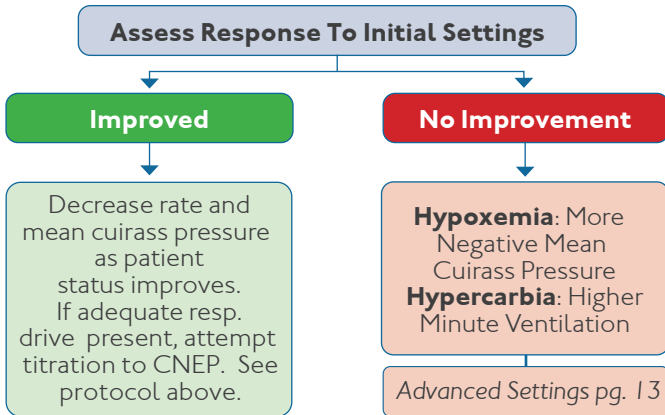
STARTING SETTINGS

Adult: -21 / +7cm

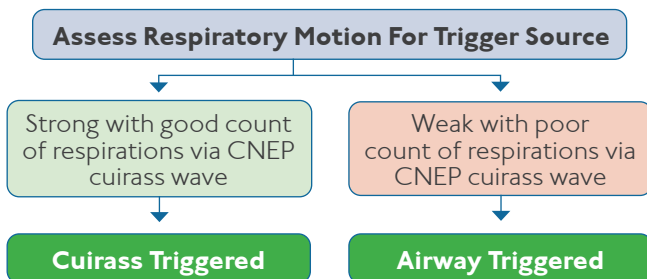
Pediatric: -18 / +6cm

Infant: -12 / +4cm

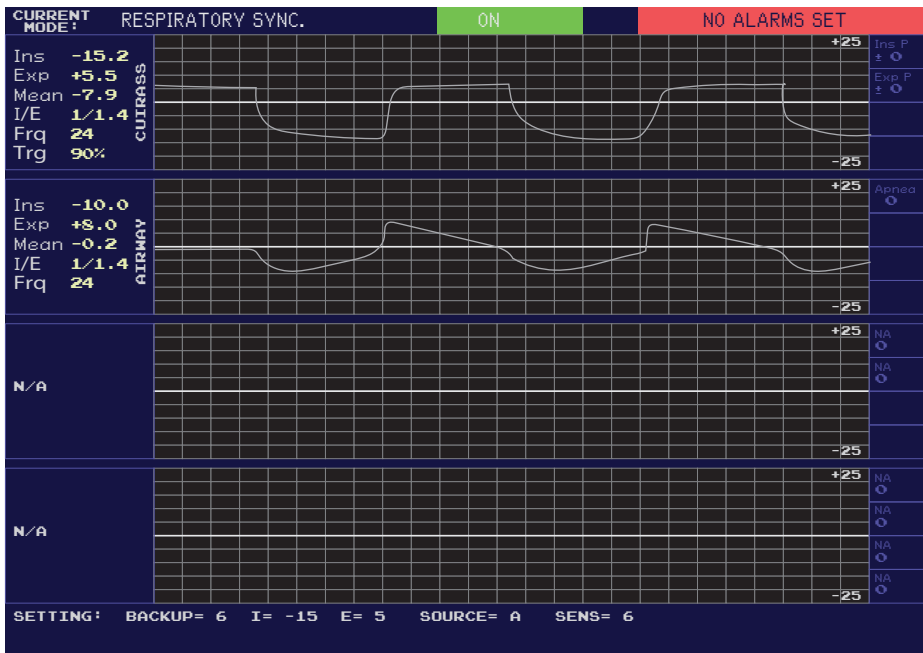
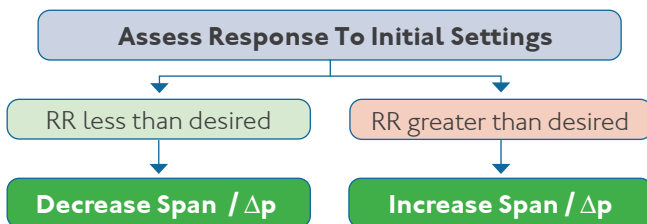
Set RR 2 above spontaneous or normal for age; I:E 1:1



Respiratory Synchronized Mode



STARTING SETTINGS
 Adult: -2l / +7cm, Pediatric: -l8 / +6cm, Infant: -l2 / +4cm
 Sensitivity 5 adjust for max synchrony



Secretion Clearance Mode

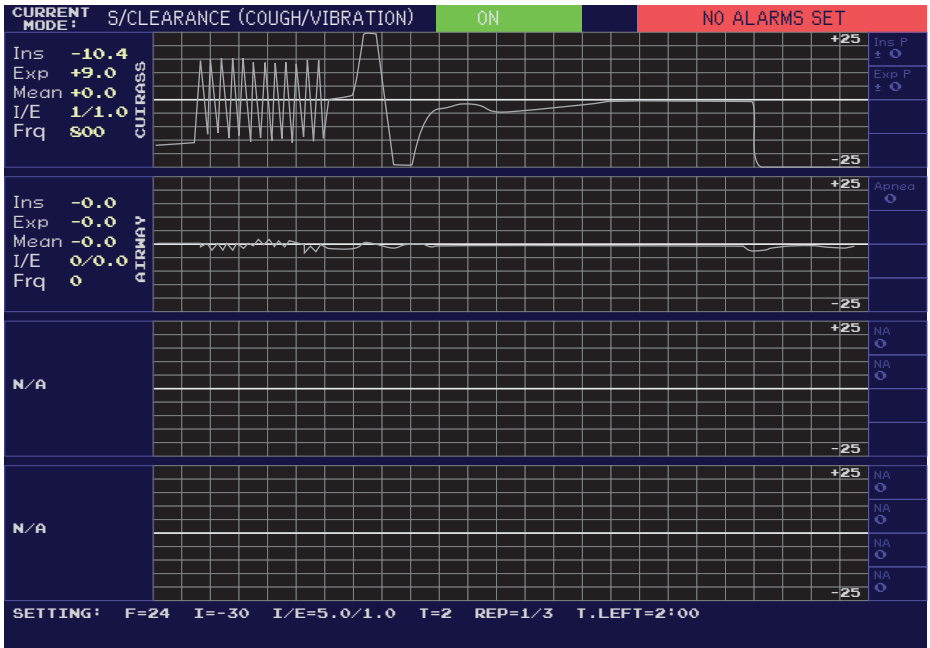
STARTING SETTINGS

	Adult	Pediatric	Infant
VIBRATION MODE			
CPM	600-800	700-1000	800-1200
Pressure (cm)	-20 to -40	-15 to -30	-5 to -20
Duration (min)	3-5	2-5	2-4
COUGH			
Insp Press (cm)	-20 to -40	-15 to -30	-10 to -20
Exp Press (cm)	20 to 40	15 to 30	5 to 20
CPM	12 to 24	24 to 36	36 to 60
I:E	4:1 to 6:1	5:1 to 6:1	5:1 to 6:1
Duration (min)	2	1 to 2	1 to 2
Repeat	3 to 6	4 to 6	5 to 6

Lower Vibration CPM for thick secretions or severe atelectasis.

For patients dependent on continuous ventilation, consider shorter durations of vibration to cough or provide occasional mask ventilation.

Device will go to Standby at end of timed treatment period; if ongoing support needed, reinitiate therapy.



Airway Considerations

Patients with unstable airways, Obstructive Sleep Apnea or other forms of soft tissue upper airway obstruction have a potential of increased obstruction with negative pressure. Patients must have a patent airway to benefit from BCV. This can be accomplished with adequate stinging pressure from CPAP, or standard airway adjuncts.

BCV may create mobilization of large volumes of pulmonary secretions to the upper airway in any mode. Oral suction should be considered for patients who may need help with secretion evacuation. For those intubated or that have a tracheostomy in place, assess frequently for need for inline or sterile tracheal suctioning. For patients with an artificial airway on secretion clearance, suction accumulated secretions during the last 10–20 second of the cough assist cycle, if needed.

Patients on Gastric Support

Use standard aspiration prevention precautions. Secretion Clearance should precede meals or bolus feeds.

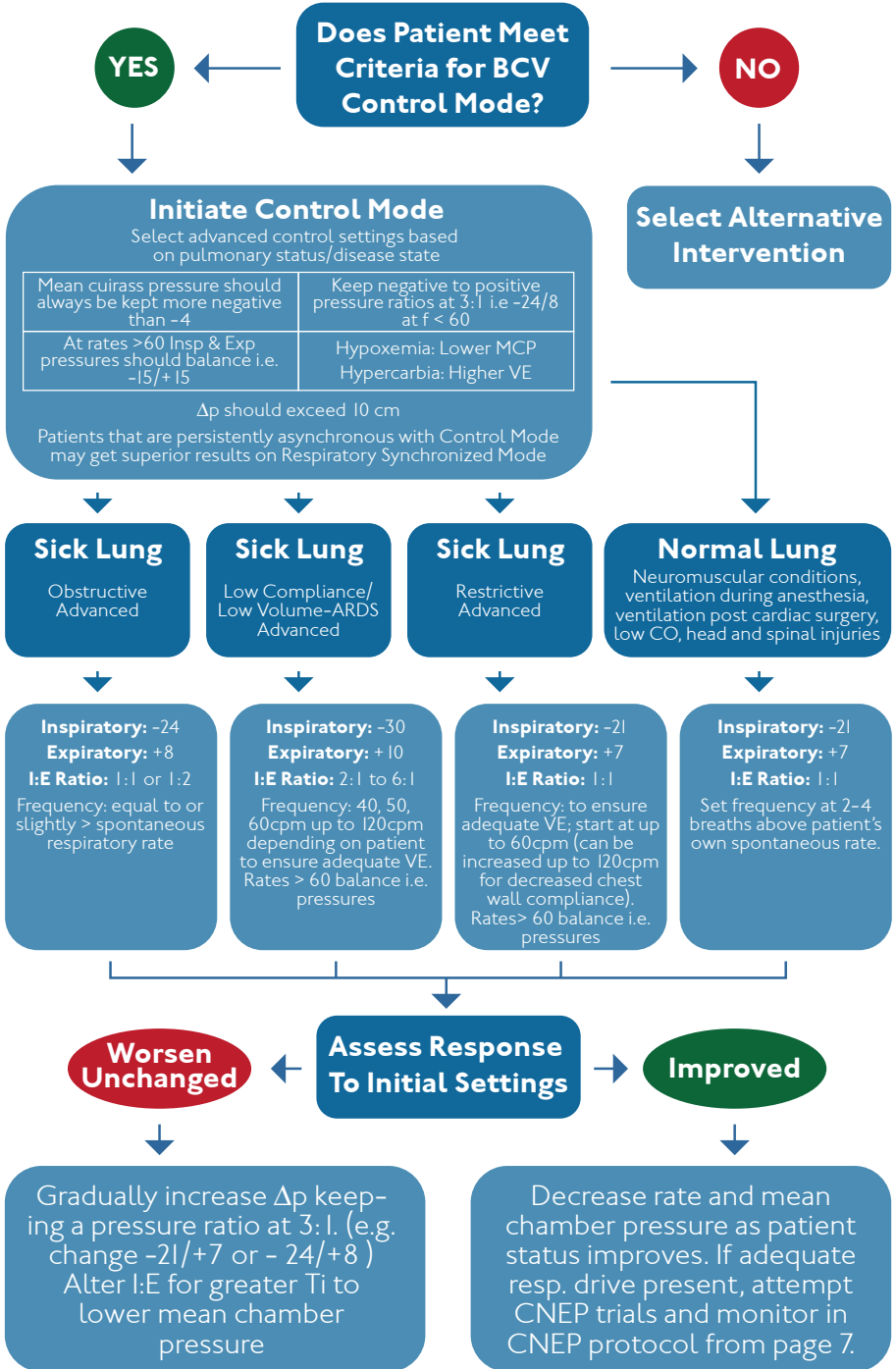
Continuous feeding may be stopped when BCV is initiated with gradually increasing resumption as tolerated.

During Secretion Clearance, briefly pausing continuous feedings before and during therapy should be considered.



- ▲ **The cuirass should not be applied directly to exposed skin but should be fitted over a loose-fitting garment** such as a cotton t-shirt or hospital gown. If the patient cooling becomes an issue, a heavier garment or light blanket can be placed between cuirass and patient. It will not alter effectiveness of therapy as long as a good seal is obtained.
- ▲ Monitor seal integrity routinely. Seals wear at varying durations based on frequency of use. Factors that can effect the longevity of the seal include, the frequency of removal and reapplications of the cuirass as well as the intensity and frequency of the therapy. A seal that is completely worn through can expose a patient's skin to an intensive pressure ridge from the edge of the cuirass. If the shell can be felt through the seal, it must be changed to a new seal without delay.
- ▲ Lines, tubes, and drains will work fine with BCV as long as the point of entry into the skin is not directly beneath the seal. The positioning of the seal can be altered slightly side to side or up and down to keep the seal from pressing directly on a line, tube or drain entry site. When entry sites are within the cuirass, and high positive pressures are used for ventilation or cough assist etc. use of petroleum or other sealing type gauze should be considered.
- ▲ Turning and repositioning should be carried out on a regular basis. Posterior pressure points must be rotated to prevent breakdown. Turns must be limited to an angle that allows maintenance of a good seal.
- ▲ Cuirass cannot be used over areas of burned skin or with active drainage.
- ▲ Cuirass can be used over well approximated, non-draining suture lines.
- ▲ Patients with misshapen thoracic structure may not be a candidate for BCV if the seal cannot be obtained. Extra padding can be attempted to increase the ability to get a seal for the patients.

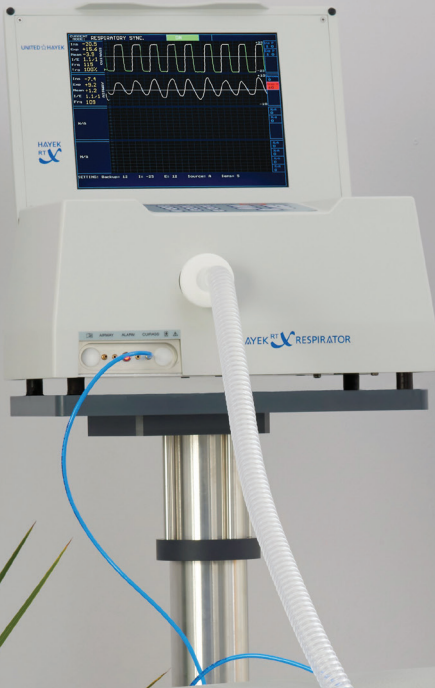
Advanced Settings Guidelines for BCV



Notes

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The late Dr. Zamir Hayek was the inventor of the Hayek RTX series of ventilators and the leading pioneer in the field of cuirass ventilation. Dr. Hayek's vision was to create a device that would provide complete ventilation, be non-invasive, work physiologically, and be simple to use. It would overcome many of the problems associated with existing ventilation techniques to provide a better quality of life for ventilator dependent patients. Through the patented technology in the Hayek RTX and the therapy provided by Biphasic Cuirass Ventilation, Dr. Hayek was able to achieve his dream of the "Ideal Ventilator".



Topics not included in this booklet can be addressed at:
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